Discover Sustainability

Perspective

An overview of psychological factors in mobility choices: the impact on pro-environmental behavior

Marilina Pellegrini[1] · **Mariaelena Tagliabue**[1,2,3]

Received: 19 February 2024 / Accepted: 17 July 2024
Published online: 24 July 2024

Abstract
Despite the current increased spread of modern mobility options in urban areas aimed at inducing changes in mobility choices, their integration into daily life remains sporadic, reducing their potential impact on the adoption of shared mobility services as a usual mode of transport. This paper provides a literature review of established models of psychological factors, including values, beliefs, and personal norms, particularly focused on pro-environmental behaviors influencing mobility choices and facilitating the adoption of more sustainable transportation habits, often supported by technological advancements. We started considering the recent increase in the complexity of cities and mobility needs, which induced policymakers to pay attention to the sustainability of people's movements by promoting various kinds of shared mobility options. Then, we illustrated the most consolidated models of psychological factors linked to ecological behaviors, also summarizing the main results present in the literature regarding variables that influence mobility choices. The final goal was to highlight crucial aspects that should be considered to foster the effective use of new modes of transportation to help reduce the environmental impact caused by traffic.

Keywords Sustainable mobility · Shared mobility · Human factors · Values-beliefs-norms theory · Pro-environmental behavior

1 Introduction

"Mobility" is a general term used in multiple research fields. Mobility, from a psychological point of view, could refer to the physical body movement, or it could indicate environmental navigation as an individual's controlled, coordinated, and goal-oriented movement in the environment to reach a specific destination [1]. Recently, it has often referred to human mobility, as people's ability to move in a particular context and through a specific transportation modality.

The latter meaning is the one we will consider in the present overview. People move daily to reach various destinations according to their goals; everyday travels are also performed for social and leisure aims [2]. In the present context, mobility refers to people's movement in space and time and therefore implicitly refers to human mobility. The daily movement of a large and growing part of the population significantly affects individuals' lives and environmental conditions [2]. However, factors such as climate change, conflict, and food scarcity were the primary drives of movement patterns [2, 3]. Today, in modern cities, other factors play a role in determining people's mobility strategies, particularly socioeconomic factors, such as differences in welfare and living conditions. Globalization also plays a growing role [2].

✉ Mariaelena Tagliabue, mariaelena.tagliabue@unipd.it; Marilina Pellegrini, marilina.pellegrini@phd.unipd.it | [1]Department of General Psychology, University of Padova, Via Venezia 8, 35131 Padua, Italy. [2]Department of Civil, Environmental and Architectural Engineering, University of Padova, Padua, Italy. [3]Mobility and Behavior Research Center—MoBe, University of Padova, Padua, Italy.

Starting from these considerations, the present report will focus on human mobility from a sustainable perspective, which is crucial for understanding the processes underlying human movement behaviors and their influence on the environment and population. In the following section, we will introduce the concept of shared mobility and will describe the variety of available services in this context. In Sect. 2, we will describe the most consolidated theoretical frameworks of the psychological aspects involved in pro-environmental behaviors supporting ecological mobility choices. In Sect. 3, we will report recent evidence regarding the psychological factors that have proven to influence the adoption of shared modes of mobility. Lastly, conclusions will be outlined in Sect. 4. The present overview summarizes the most significant contributions to provide the reader with a comprehensive understanding of the current state of the art in the field of sustainable and shared mobility from a psychological point of view.

1.1 Sustainable mobility and shared mobility

The term "sustainable" is widely used in the field of mobility. Today, the term is often used without defining what specifically sustainable mobility is or how it should be fostered in our urban cities. Several definitions of sustainable mobility are reported in the literature, but there is no agreement on an overall general definition [4, 5].

Recently, sustainable urban mobility has been defined as "a city that motivates its inhabitants to change their travel behavior toward minimizing their emissions and noise impacts on health and the environment" [3]. In urban areas, transportation mobility influences sustainability and quality of life. Air pollution, noise, congestion, and occupation of public space, caused by traffic, considerably characterize cities. Moreover, these factors increase the number of accidents and likelihood of pollution. Therefore, the effects of urban transportation contribute to global climate change. The conceptualization by Foltýnová et al. of sustainable mobility suggests that it is necessary to change citizens' travel behavior to achieve sustainable mobility's main aim: reduce the impact on the environment [3]. Consequently, it is very important to promote a behavioral change in human beings to act in a more sustainable way to reduce traffic's impact on the environment. Commonly, "sustainable mobility" refers to modes of transportation classified as ecological, such as local public transportation, cycling, and walking. However, these types of transportation cannot be used to reach all destinations or to answer all people's issues and needs. Taking into account this aspect and to better answer the variety of inhabitants' requests, a wide range of transportation mobility alternatives was implemented, including shared vehicles.

The complexity of cities has recently increased [6]. As a result, citizens' needs, requirements, and issues have changed extensively, especially in the field of mobility, depending on goals that lead people to move around the city and individual lifestyles. This change has contributed to the emergence of new means of sustainable transportation, namely shared mobility. Shared mobility, or mobility in a sharing economy, can be described as trip options, available in urban contexts, aimed at increasing the use of mobility resources provided to reduce private-vehicle usage [7]. The basic assumption of this innovative transportation strategy is that the shared use of a vehicle allows people to gain access to transportation systems on the basis of collective needs and common destinations. Shaheen et al. [8] defined shared mobility as "the shared use of a vehicle, bicycle or other low-speed modes that enables users to have short-term access to transportation modes" that fit their needs, in contrast to vehicle ownership. Therefore, shared mobility consists of sharing a vehicle, consequently reducing vehicle ownership, and using technologies that allow for connections between users and providers. This new way of moving in the urban context includes various types of modalities, in which shared mobility is a general term that involves a wide range of innovative transportation modes with different travel behavior impacts. The classification of shared transportation modes that Machado et al. [7] introduced is a suitable guide for better understanding this complex transportation mode, which we describe below. The five principal types of shared modes are as follows:

- Carsharing: *station based* (round-trip and one-way) and *free floating* (one-way);
- Personal vehicle sharing: *P2P carsharing* and *fractional ownership*;
- Bikesharing;
- Ridesharing: *carpooling* and *vanpooling;*
- On-demand ride services: *ridesourcing* and *ridesplitting.*

Carsharing is a type of shared transportation that consists of the use of the same vehicle by multiple people. Specifically, carsharing requires that the users access vehicles through an organization that makes available a wide array of vehicles in cities. Therefore, the carsharing organization provides fuel, parking, and maintenance of vehicles, and the users pay each time they use a vehicle. The use of carsharing has spread thanks to several advantages (either from an environmental and social perspective), including the beneficial effect of moving without responsibilities and costs related to owning a

private car. Other benefits of carsharing include reduced frequency of car use as well as fewer vehicles owned and used to move in the urban context. Carsharing is divided into two subtypes: station-based and free-floating. The first consists of a two-way service, in which the users pick up the vehicle and return it at the same assigned station (round trip) or at another designated station (one-way). Vehicles are located in a pick-up station; therefore, this type of carsharing requires that the users book their cars in advance. The second type of carsharing allows users to pick up and return the shared vehicle anywhere within the service area, but they can move outside the service area. Although there are no specific stations, users still have to return cars within the area the service covers, using designated car parks. Free-floating (one-way) carsharing services allow users to track the shared vehicles and book them online using a smartphone or computer.

A further type of shared mobility is personal vehicle sharing, which consists of sharing one's vehicle, thus making it a shared car, and renting it to other drivers for a specific time. This class of shared mobility includes two subtypes. The first is peer-to-peer carsharing, in which people supply personal vehicles temporarily for the shared use of other drivers through a mediator (operator service). The operator provides the rental procedure and the information about the vehicles' availability. This type of carsharing includes a greater range of vehicle types and rental prices than the standard carsharing modes. The second type, fractional ownership, involves sharing vehicles among a specific group of people and all of the people in that group paying for access to the shared service. Therefore, the group of people using the vehicle through fractional ownership is generally restricted; indeed, the single carsharing vehicle is used within an exclusive user group. Furthermore, fractional ownership allows people to access a particular type of vehicle, such as electric vehicles.

Another shared-transportation mode is bikesharing, an analog to the carsharing modality, but the vehicles involved are bicycles. Indeed, users can access bicycles on demand through bikesharing stations, which are located in urban centers. Bikesharing services provide two types of access: station-based one-way (the user can return the bicycle to any station) and station-based round-trip (pickup and delivery stations must be the same). In general, the users have to pay for the service through a monthly or annual subscription and make an additional payment for each journey via an online platform with their smartphone device.

Ridesharing is another shared transportation mode, which gathers individuals with the same destinations and departure times together in a single vehicle, usually a car or a van. It is a valid way to limit congestion given that people travel together in the same vehicle. This modality has increased the use of vehicle sharing platforms through smartphone applications because people can communicate with each other to better manage the individual use of the vehicle by providing real-time traffic information to the other drivers. Therefore, it is a dynamic mode of transportation thanks to instantaneous communications between drivers and passengers who share the same destination. The most popular ridesharing modalities are carpooling and vanpooling. The first is the informal form of ridesharing among commuters, in which two or more individuals (family members excluded) share a part of or an entire trip and all contribute to the travel's costs. This mode is usually used by people to reach the same destination, such as school, university, or work, and it is often employed among acquaintances or colleagues. Vanpooling entails the sharing of a van or a large vehicle among a restricted group of 7 to 15 people linked by a common route. They share the operating expenses and the responsibility of driving, which leads to a series of benefits, such as reliability; social interaction; stress reduction; and financial, ecological, and environmental advantages. The last class of shared transportation modes Machado et al. [7] proposed is on-demand ride services, which allow people to access various transportation options anytime through their smartphones. Indeed, their popularity arises from the convenience of a door-to-door service always available as well as decreased travel times and costs. The most famous are ride sourcing and ride splitting, which are very similar, but the first involves personal mobility, which entails transportation services that are steady, personalized, and highly flexible and aimed to address individual requests by providing door-to-door service, whereas the second involves passengers with similar routes who travel in the same vehicle.

As shown, the majority of the presented services are bookable through smartphone applications. These applications allow people to plan trips based on their needs and choose the most convenient transportation service [9]. In addition, shared mobility includes some alternative services that extend fixed-route bus and rail services. The various options shared mobility provides are often available through smartphone apps, and these options can offer the best combination of services to allow users to reach their destination. Therefore, these innovative travel modes offer new transportation and delivery modes. The classification previously described enables us to better define the types of shared transportation modes and highlights their complexity to give a comprehensive definition of shared mobility.

Nevertheless, shared mobility significantly affects many global cities thanks to the network services that have the potential to change the nature of transportation modes. As Banister [10] suggested, encouraging the use of alternative modes of mobility does not mean prohibiting the use of cars but rather promotes a new concept of transportation modes, especially in cities in which people do not need to own a car. The author suggests that this alternative approach

involves new thinking about cities concerning reality, desirability, and the role that transportation should play in achieving sustainable mobility goals. Therefore, the main aim of shared mobility remains the same: to decrease the number of private vehicles in each family and create new mobility habits that could lead to the adoption of shared-transportation services according to their convenience. Therefore, it could be possible to assume that shared mobility is a subclass of sustainable mobility, with the same main aim: to reduce the environmental impact.

Today, many difficulties arise due to traffic jams and environmental deterioration of urban areas, caused by the fast diffusion of motor vehicles moving in a chaotic way, vast urban expansion, low efficiency of public transportation systems, and little availability of infrastructure for pedestrians and bikers [7, 11]. For these reasons, transportation is one of the most problematic fields of interest today, especially when we focus on negative transportation congestion and pollution, traffic accidents, and their economic, social, and environmental implications. Therefore, shared mobility consists of urban mobility, which could come from an alternative transportation service offering the possibility of major changes [12]. Machado et al. [7] suggested that shared-transportation modes could reduce traffic congestion, decrease the number of vehicles on the road, and in general, mitigate the environmental impact. However, the diffusion of these new transportation systems depends on multiple factors, such as demographic and cultural changes, new social attitudes, and advances in mobile technology. Therefore, shared mobility requires the integration of multimodal services that may be delivered through digital platforms that support users in their transportation choices and allow them to monitor the journey information.

Based on this premise, it is important to consider that accessing shared mobility services is not easy for the entire population. Indeed, users are required to access the Internet through their digital devices and possess a valid bank card for the payments. This could exclude poor or older people. In addition, this type of mobility is available for the majority of citizens in urban centers but excludes inhabitants who live in peripheral regions, which is a difficulty in using the services. Therefore, it is very important to include sociodemographic characteristics when studying urban mobility, whether from a sustainable or shared perspective, to promote pro-environmental attitudes.

In summary, shared mobility is proven to offer integrated on-demand multimodal services, accessible through digital platforms, that help users optimize their transportation choices and provide information useful for monitoring online the trip, weather, and traffic conditions. This makes urban travel convenient, controlled, and resilient. Therefore, from a sustainability perspective, interventions aimed at introducing connected, shared, and less polluting vehicles (e.g., electric) can help improve the transportation sector, encouraging sustainable growth in urban contexts and allowing for controlled and convenient travel [13]. Therefore, it is possible to assume that shared mobility is a kind of sustainable action by urban citizens. Indeed, the choice of means of transportation could be included in the set of pro-environmental behaviors, which consists of all the actions and strategies that help reduce transportation modes' impact on the environment.

In the next paragraph, we present definitions and evidence from the literature concerning pro-environmental behaviors and their implications for urban mobility.

2 Psychological aspects of ecological behavior

Pro-Environmental Behavior (PEB) is a term widely diffused throughout the literature. Many authors have different definitions of PEB. Kollmuss and Agyeman [14] define PEB as a behavior "that consciously seeks to minimize the negative impact of one's actions on the natural and built world (e.g., minimize resource and energy consumption, use of nontoxic substances, reduce waste production)" [14]. Steg and Vlek suggested that "PEB refers to behavior that harms the environment as little as possible, or even benefits the environment" [15]. In addition, PEB includes all types of behavior that change the accessibility of resources from the environment or modify the biosphere's functioning and ecosystems [16]. Therefore, the general and accepted definition by most scholars refers to an intentional action capable of limiting a negative impact on the environment [16]. Nevertheless, scholars have used a multitude of definitions of PEB, such as "responsible environmental behaviors", "ecological behaviors", "conservation behaviors", "environmentally supportive behaviors", "environmentally significant behaviors", and "eco-friendly behaviors" [17]. We will use "pro-environmental behaviors" considering the term a subset of environmental action [18]. Nevertheless, the question of what shapes PEB is still complex and unsolved. The literature offers various theoretical frameworks that allow for improved knowledge of the factors that guide and promote PEB. These models are intended to better understand the basic functioning of PEB, considering it a complex construct comprising other underlying factors.

Authors have developed various types of models to explain which factors enhance PEB and their relationships. Kollmuss and Agyeman [14] proposed a theoretical model (see Fig. 1) considering PEB as a multifactorial construct. As Fig. 1 shows, the model involves various types of factors that play a role in determining PEBs.

Regarding Kollmuss and Agyeman's theoretical model, external and internal factors contribute, directly and indirectly, to PEBs [14]. External factors include (1) institutional factors (e.g., political situation and infrastructure) that showed a consistent influence on the manifestation of PEB (e.g., recycling or using traffic transportation), in which the willingness to adopt a PEB is related to the impact of public policy and government regulations [19]; (2) economic factors that have been demonstrated to be involved in performing environmental actions, in which policies, rules, and regulations affect and guide people's decisions regarding the consummation and the transportation sectors; (3) social and cultural factors, in which norms showed a strong influence on shaping people's actions, including PEBs.

The model also considers some internal factors. Motivations are categorized as primary motives, such as the adoption of an environmental lifestyle, and selective motives, (e.g., the decision of which type of means of transportation to use for achieving a specific destination) [20]. The authors hypothesized that primary motives that reflect environmental values (e.g., altruistic values) are covered up by the selected motives, such as personal comfort. Knowledge and awareness of environmental issues were other internal factors. As Liu et al. [21] discovered, environmental knowledge improves environmental attitude, which has a relevant positive influence on intention in favor of the environment and PEB. Another internal factor involved in the model regards values. Indeed, Gatersleben et al. [22] showed that the values (especially biospheric and altruistic values) were strongly related to environmental identity. Therefore, environmental identity was significantly linked to the intention to adopt PEBs, and values reflect a further propensity for ecological behavior. Attitudes are also included in the internal factors. In particular, Wyss et al. [23] found that the relationship between environmental attitudes and behavior was more relevant when personal costs were low. Therefore, in the case of pro-environmental decisions that require low effort, the environmental attitudes proved to be an effective predictor of PEB. Emotional involvement is another internal factor, which Kollmuss and Agyeman [14] defined as the "affective relationship to the

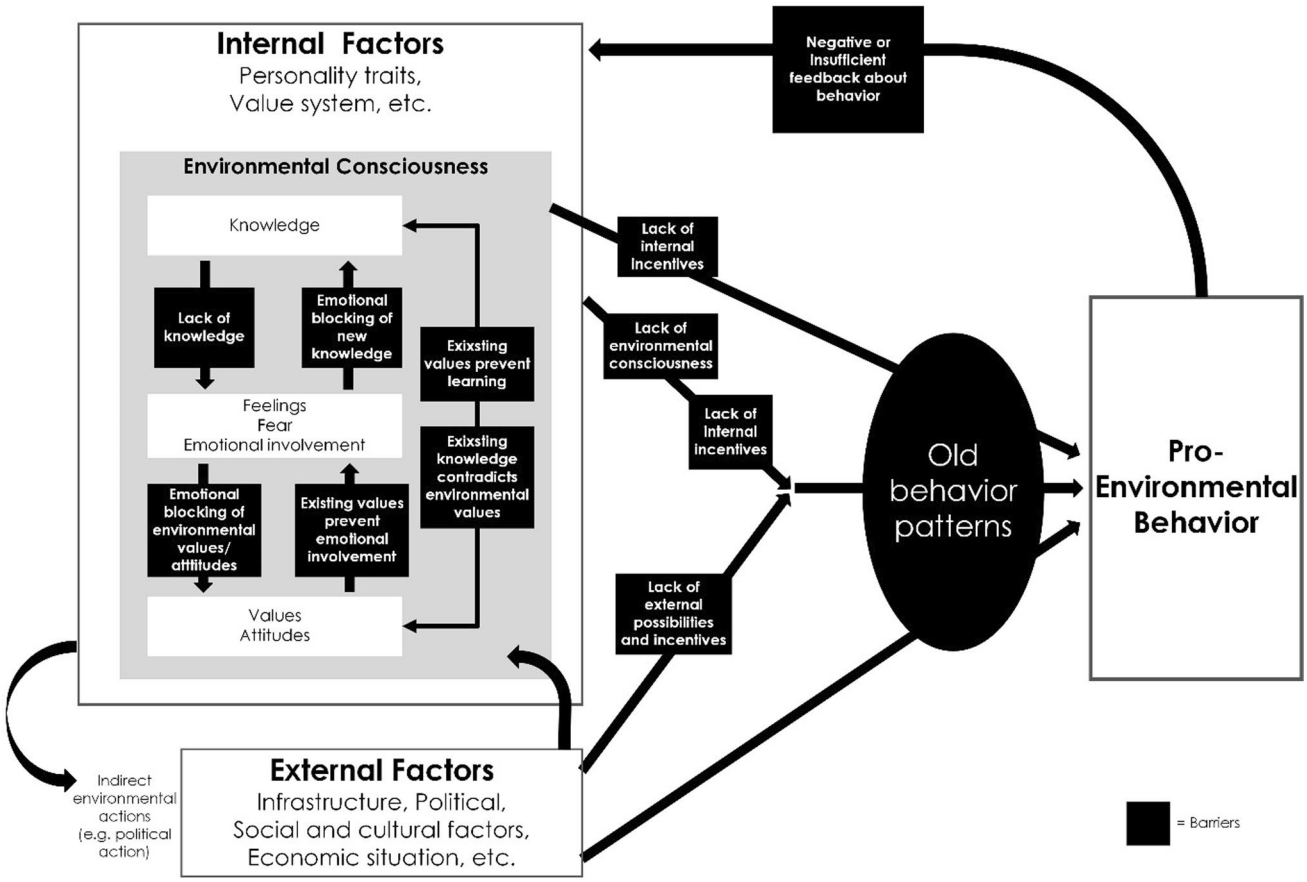

Fig. 1 Model of pro-environmental behaviors proposed by Kollmuss and Agyeman [14]. Black boxes represent possible obstacles to pro-environmental behaviors

natural world." This was also confirmed by Hinds and Sparks [24], who showed that the affective connection to the natural environment was significantly related to environmental-behavior intentions, environmental attitudes, subjective norms, and environmental identity. Therefore, greater emotional involvement indicates a better predisposition in favor of the environment and a stronger intention to adopt ecological attitudes and behaviors. Therefore, emotional involvement, in terms of the affective connection with the environment, shapes PEB [14]. Another internal factor included in the model is the locus of control, which refers to an individual's perception of their effectiveness in influencing what happens. The authors suggested that the belief that a specific action could produce a change was linked to an internal locus of control. Therefore, an internal locus of control supports ecological actions. The last internal factors are responsibilities and priorities. The authors showed that people's priorities concern their well-being and that of their relatives; therefore, when personal priorities and PEB are coordinated, the motivation to act in an ecological manner increases. To summarize, in Kollmuss and Agyeman's [14] model, internal and external factors act directly on PEB and generate environmental actions. Moreover, the greatest positive influence on PEB was observed when internal and external factors work together to shape PEBs.

It is worth noting that demographic factors, such as gender and year of education, have also been demonstrated to influence environmental attitudes and PEBs [25]. Other individual factors that play a role in promoting PEB include demographic characteristics, environmental knowledge, personality traits, and positive expected affect, as Zhao et al. [26] found. Their study focused on interpretative services (i.e., guided interpretive services, such as guided tours, lectures, and discussions, or self-guided interpretive services, such as signs, self-guided trails, and motor tours) used in parks to offer information about knowledge and values of natural and human resources and to enhance the recreational experience. The main aim of the study was to detect the significant factors that impact on promotion of visitors' Environmentally Responsible Behaviors (ERBs) in urban parks. A total of 567 visitors in Beijing's Yuyuantan Urban Park (China) participated by completing a questionnaire that assessed personality traits, satisfaction with interpretive services, place attachment, and ERBs. Personal traits were measured using the Costa and McCrae's [27] Personality Trait Scale. It identified five types of personality: neuroticism (3 items), extraversion (3 items), openness (3 items), agreeableness (3 items), and conscientiousness (3 items). To evaluate the satisfaction with interpretive service, the authors developed a scale that was divided into satisfaction with educational service (3 items) and satisfaction with experiential service (3 items). Place attachment included place identity (3 items) and place dependence (3 items). Finally, ERB was measured using a scale that contained general behaviors (3 items) and particular behaviors (3 items) related to tourism destination. In addition, the instrument inquired about the participants' demographic characteristics, such as gender, age, education, occupation, residence, and purpose for visiting. The questionnaire's internal consistency and reliability were successfully tested. Through structural equation modelling, Zhao et al. [26] showed that personality traits and place attachment directly influence ERBs whereas satisfaction with interpretative services indirectly impacts ERBs, with place attachment as the mediator. Specifically, the original contribution by Zhao et al. [26] is the influence of personality traits, such as openness, on the use of public transportation [28]. The final suggestion by Zhao et al. [26] was to consider these factors in studies focused on transportation mobility.

Taken together, the evidence described allows us to assume that people's decisions about transportation modes to use to reach a specific destination are guided by psychological variables that shape PEB. Therefore, the choice of means of transportation could become an action in favor of the environment if individuals understand their choices' environmental impact [7, 29]. However, citizens need to make many mental and behavioral changes to adopt PEB. Indeed, PEBs imply innovative thinking about the future of cities, taking advantage of resources that are already present, but also involve the implementation of new services [10]. Changing perspective is essential for the adoption of mental openness and the disposition to use alternative and unusual modes of transportation to behave in favor of the environment.

The next paragraph highlights the importance of investigating the psychological constructs that have been shown to be related to the PEB intention in the field of mobility.

3 Implications for ecosystem threats

Today, various environmental problems impact the Earth and threaten its ecosystems. The majority of them have arisen due to human behavior [15]. Actually, all behaviors performed by people have environmental consequences [30]. The adoption of more eco-friendly behaviors can reduce environmental impact and climate change consistently [31, 32]. To limit environmental harm and simultaneously increment knowledge about ecological actions, it is necessary to identify the underlying psychological factors involved in the PEB model. The final goal is to promote behavioral change and to

answer the environmental issues. To do so, it is necessary to better understand what shapes PEB to encourage mental and behavioral change in favor of the environment. The models described in the previous section are aimed at defining psychological theories that explain the factors promoting behavior in favor of the environment.

It has been shown that PEBs consist of a number of underlying components that influence an individual's intentions and the likelihood of performing an effective PEB. The previously addressed theories proposed theoretical frameworks to explain which factors promote the actual implementation of PEBs from a general perspective, and in the present section, we will consider the psychological aspects involved in in PEBs in the context of mobility.

Several studies have shown psychological factors' influence on the intention to use eco-friendly mobility services. For instance, Jin et al. [32] conducted a survey to individuate factors influencing the adoption of battery electric vehicle sharing services and showed that, among others, environmental awareness plays a role, thus suggesting that interventions aimed to promote the adoption of this kind of service might benefit from campaigns focused on the environmental benefits the service entails. This result is also confirmed in the Norwegian population by Hjorteset and Böcker [33], who found that environmental concern emerges as a key factor in the willingness to use carsharing, as attested by the fact that people who are already car sharing members are more environmentally conscious and that environmental consciousness leads to a lower likelihood of owning a private vehicle. On the other hand, Mattia et al. [34] conducted a similar investigation in Italy, a country in which owning a car has symbolic and emotional valence, what makes Italy the European country with the highest number of circulating vehicles per 100 inhabitants in comparison with Germany, Spain, and France. The authors applied the theory of planned behavior to better understand the motivations that influence the willingness to re-use free float carsharing. The results indicated that social, economic, and environmental dimensions influence attitudes toward free car sharing, but environmental aspects play a minor role.

However, services such as ride-hailing and carsharing are not always considered eco-friendly. If, on the one hand, they can reduce the number of circulating vehicles, on the other hand, their net contribution to the environment depends on the presence of other less polluting or less congesting alternatives. Therefore, the results may differ in different geographical areas and countries. For instance, Gomez et al. [35] showed that low environmental consciousness is associated with a propensity for car use and, consequently, a greater tendency to use ride-hailing services in the city of Madrid. Conversely, a high environmental consciousness is linked to a greater frequency of use of more sustainable transfer modes, such as public transport, which may explain the lower likelihood of using ride-hailing. This result is coherent with the negative correlation Aguilera-García et al. [36] found between pro-environmental attitudes and carsharing adoption in the Madrid population, which is interpreted in terms of a greater propensity to adopt more eco-friendly means of transport and the negative correlation between environmental awareness and frequency of use of carsharing in Munich. Both results seem to indicate that carsharing is not perceived as an eco-friendly mode of transport in the considered cities, thus suggesting the opportunity of policies able to combine public transport with carsharing services depending on the specific area's needs. In addition, this evidence supports the idea that more attention should be paid to the frequency of use of mobility modes.

The comparison with a more recent study by Aguilera-García et al. [37] on the use of e-scooters, which are considered eco-friendly (in that they produce fewer emissions and less traffic congestion), aligns with the previous considerations: environmental consciousness correlate positively with the adoption of private e-scooters and the frequency of use of shared e-scooters. This result suggests that the general population perceives micromobility vehicles as an environmentally friendly mode of transportation. Consequently, an increase in environmental awareness may result in increased adoption and use of e-scooters, despite high levels of safety concern.

Litman [38] suggested that choices regarding transportation modes depend not only on quantitative factors, such as speed, operating costs, crash rates, and safety, but also on qualitative factors that concern convenience, comfort, reliability, and travel time, which are more related to the individual's expectations and satisfaction regarding transportation modes. Other factors that must be taken into account are stable psychological factors, such as dispositional variables, that may affect behavior over long periods, such as attitudes (pro-environmental beliefs, preference for a transportation mode), habits, and demographic characteristics (social status, gender, and age) [39]. Moreover, most of these factors contribute to behavioral change by determining the level of intention to shift to more sustainable means of transport. For instance, Eccarius and Lu [40] conducted a study to investigate the factors influencing the intention to use an electric scooter sharing service among university students in Taiwan and demonstrated that the lack of perceived compatibility with personal values, mobility needs, and lifestyle is a significant factor in driving students with low usage intention. In addition, the formation of intention is indirectly influenced by awareness of the sharing system and environmental values.

Specifically, psychological variables determining pro-environmental intentions in the field of mobility choices are described in the Values-Beliefs-Norms Theory (VBNT) proposed by Stern et al. [16, 41], which is represented in Fig. 2.

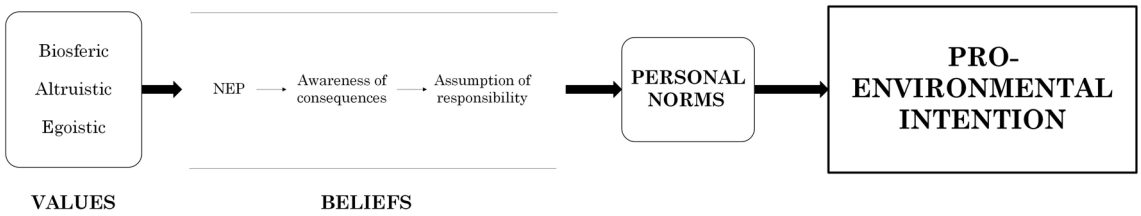

Fig. 2 Schematic representation of the VBNT proposed by Stern et al. [16, 41]. NEP: New Environmental Paradigm

The VBNT is widely used in the literature, especially for studying pro-environmental behavior intention. The theory suggests a model aimed to investigate which factors are involved in sustainable behaviors from an environmental perspective. The model considers three types of variables: values, beliefs, and norms (see Fig. 2). Concerning values, Stern referred to the definition Schwartz [42, 43] provided, according to which they represent "trans-situational objectives with varying degrees of importance, which serve as guiding principles for the life of an individual or other social entities" [42, p. 21]. These values are categorized as altruistic values, biospheric values, and egoistic values. Regarding beliefs, the VBNT includes general considerations about the environment that refer to the New Environmental Paradigm (NEP) [44, 45]. Specifically, the NEP is focused on human activity's impact on the environment, the existence of limits on the growth of human societies, the need to balance economic growth with the protection and safeguarding of the environment, and the importance of ensuring and preserving the biological balance of nature. Another group of beliefs is related to the awareness of consequences for the environment, which could represent a threat to what the individual considers valuable (people around them, animal species, biosphere). Finally, the assumption of responsibility (or ascription of responsibility) concerns individuals' actions aimed at reducing the negative consequences that threaten ecosystems. The last construct mentioned in the model by Stern et al. refers to personal norms (or moral obligations), which are social rules that define how individuals should behave [16]. On the basis of the VBNT, several studies have focused on the relationship between individual values (specifically altruistic), beliefs (environmental concern, awareness of consequences, assumption of responsibility), and personal norms concerning pro-environmental actions. The results Stern et al. [41] obtained showed that these variables are so related that they influence each other. Personal values influence individuals' environmental beliefs and shape their attitudes toward and intentions regarding PEBs, as evident in the observation that people with strong biospheric values show more frequently positive environmental attitudes [41].

Concerning environmental beliefs, the findings showed they played a role in determining individuals' attitudes toward and intentions regarding PEBs. For example, people who believe that human activities significantly harm the environment show a more positive attitude toward sustainable actions. It is important to highlight that environmental concerns (beliefs about the limits on the growth of societies and the rights of human beings over nature as well as the concern that humanity could impair the balance of nature) have proven to play a significant role [45]. In addition, Gifford and Nilsson [46] showed that it is not sufficient to investigate this aspect with self-reported instruments because the reported behaviors reflect the actual behavior. Considering that being in favor of the environment is a widely accepted behavior, the reported behavior reflects social desirability. Nevertheless, Gifford and Nilsson [46] also focused on a meta-analysis that showed a closely significant correlation between behavior intentions and actual behaviors. This means that intentions can reflect actual action. Based on this evidence, it is possible to assume that studies on PEB intention can be useful [47].

Finally, the findings by Stern et al. [41] regarding the last dimension of VBNT suggest that personal norms significantly impact individuals' intentions and behaviors (for instance, people who believe that their friends and family support or are engaged in pro-environmental actions likely feel more obligated to do the same). Summarizing, the model reported in Fig. 2 indicates that psychological dimensions (personal values, environmental beliefs, and personal norms) are closely linked to each other in their influence on behavioral intentions. Moreover, positive values and beliefs about the environment, together with supportive social norms, led to stronger intentions to engage in environmentally responsible behaviors. Consequently, strong intentions regarding PEB, together with positive personal values, beliefs, and perceived social norms, increase the likelihood of individuals performing PEBs. In conclusion, the VBNT is an evidence-based theoretical framework aimed at explaining the psychological dimension underlying the intention to act in an environmentally responsible manner. Therefore, the model could be a useful background in the context of sustainable mobility in that the intention to perform a PEB also means an increase in the likelihood of choosing and adopting ecological means of transportation [29].

Habits and frequency of use were also shown to play an important role during decision-making regarding transportation [48, 49] as well as how people perceive a certain mobility service. Mitra and Hess [50] demonstrated the importance

of exploring the frequency of use of shared e-scooters in Toronto, examining also the impact of sociodemographic, attitude, and environmental factors. The findings suggest that most potential users would be willing to replace their trips with e-scooters, especially if walkability/bikability and street safety increase. Moreover, the preference for efficient travel as well as environmental and health awareness have shown to be positively correlated with future potential use of e-scooters. Another interesting contribution proposed by Blazanin et al. [51] suggests that psychosocial attitudes should be considered in the adoption and use of e-scooter sharing systems (ESSs) and bike sharing systems (BSSs). The results indicated that there is an indirect influence of demographic variables. In particular, psychosocial attitudes of safety concern, time awareness, and green-lifestyle propensity mediate ESS/BSS use. Consequently, it is crucial to consider the combined influence of psychosocial factors and demographic characteristics when attempting to encourage sustainable forms of travel, such as ESSs and BSSs.

In this regard, Vega-Gonzalo et al. [52] conducted a study to identify the factors contributing to the frequency of use of e-moped sharing. These factors included socioeconomic characteristics, self-reported travel behaviors, and psychological preferences, with particular attention to environmental consciousness, level of comfort in using technology, and willingness to share. In accordance with the findings by Aguilera-García et al. [36], environmental consciousness is primarily influenced by gender and age. In addition, more favorable attitudes toward the environment are predominantly observed in women and adults between the ages of 44 and 65. The level of comfort with technology increases with income and education level and decreases in older adults. Willingness to share tends to be higher among women and individuals living in middle-income households. Regarding the frequency of use, age exerts a significant influence, with older individuals exhibiting a reduced propensity to utilize services, a finding that supports previous research [36]. Overall, the results indicate that the frequency of use of shared electric mopeds is higher among wealthier youth and residents of urban centers, that more frequent use of shared electric mopeds is negatively correlated with the belief that private vehicles will remain a necessity in the future, and that this effect seems more pronounced among high-income groups and those who combine e-moped sharing with other sharing services. These contributions are important starting points for promoting the use of shared micromobility in urban and surrounding areas, where these modes of transport are not always available.

Perceptions were also proved to be predictors of intentions to behave in pro-environmental ways. In particular, Zaigham et al. [53] extended a Technology Acceptance Model (TAM), which is a widely recognized theoretical framework that helps explain and predict how users accept and adopt new technologies. The TAM is based on the idea that users' attitudes and perceptions significantly influence their usage of a technology.

Zaigham et al. [53] expanded the TAM, introducing governmental regulations and integrating perceived risk and trust to investigate the relevant variables involved in the usage of a ride-hailing service. The authors administered a questionnaire to a sample of ride-hailing drivers across Malaysia, in which respondents had to indicate their degree of agreement (on a 5-point Likert scale) concerning the ride-hailing service. The attributes investigated were intention to use (5 items), actual usage (2 items), perceived ease of use (5 items), perceived usefulness (3 items), perceived risk (10 items), trust (17 items), and governmental regulations (6 items). The results suggested that the intention to use a ride-hailing service is directly and significantly influenced by perceived usefulness, perceived ease of use, and governmental regulations, which can help increase the likelihood of using the ride-hailing service. Referring to the mediation analysis, the results showed that the effects of perceived ease of use, perceived usefulness, perceived risk, and government regulations on intention to use were mediated by trust. Finally, a significant indirect effect of intention to use on actual use was found, with trust as a mediator factor. Overall, the results of Zaigham et al. [53] are very relevant in that they allow us to better understand the influence of the variables investigated on the acceptance and adoption of a sustainable mode of mobility.

Moreover, the study conducted by Zaigham et al. [53] provided a valid theoretical framework to investigate the psychological aspects involved in sustainable mobility choices and the individual's intentions to accept and adopt transportation modes and services that require the usage of technology. Therefore, in the context of sustainable mobility, it is relevant to explore also the general perceptions of these kinds of technologies. In this regard, technophilia also seems to play a role. Schlüter and Weyer [54] claimed that technophilia consists of the disposition and openness to the use of new technologies, suggesting that individuals' attitudes in relation to technological progress warrant consideration in studies aimed at investigating technology acceptance because technophilia involves emotions related to innovations and motivations for accessing innovative products or services. The authors investigated the influence of the independent variables car ownership, multimodality, urbanity, ecological awareness, technophilia, car sharing experience, and perceived ease of use, to predict the behavioral intention to use an electric vehicle, which reflects the general acceptance of new technology. First, the results showed that the two TAM components (perceived usefulness and perceived ease of use) significantly affect behavioral intention and, consequently, overall technology acceptance. Another important result

concerns technophilia's causal effect on perceived ease of use, increasing acceptance. Therefore, this seems a relevant aspect to take into account in studies of mobility modes of choice, especially regarding the transition to shared modes of mobility because shared mobility is often accessible through the use of new technological tools, such as smartphone applications. This is confirmed by other recent research, showing that individuals with a high degree of technophilia are more prone to use mobility innovations [55, 56].

4 Conclusion

Research has highlighted the role of psychological factors that influence pro-environmental behavioral intentions and the willingness to adopt shared mobility. The VBNT, as Stern et al. [16, 41] proposed, posits that personal values, environmental beliefs, and personal norms are closely interrelated and exert a significant influence on behavioral intentions. In particular, individuals with strong biospheric values and positive beliefs about the environment, joined with favorable social norms, are more likely to engage in ecological behaviors. Moreover, other studies have indicated that the frequency of use of means of transport plays a significant role in the decision to adopt a new form of mobility. Regarding specific aspects of shared mobility, individuals' perceptions of the ease of use, perceived usefulness, and government regulation of sustainable mobility services directly impact people's intention to use such services. As Zaigham et al. [53] demonstrated, trust acts as a mediator, translating perceptions into actual behavior. Moreover, technophilia, or the positive disposition toward the use of new technologies, emerges as a determining factor in the transition toward shared mobility modes. People with a high degree of technophilia are more likely to adopt mobility innovations, which are often accessible through technological tools, such as smartphone applications. Consequently, the research presented indicates that the combination of pro-environmental values, positive perceptions of safety, and ease of use, together with a predisposition to new technologies, can promote the adoption of shared modes of transport, increasing the utilization of sustainable mobility services.

Taken together, the literature examined in the present overview strongly suggests that the set of variables influencing mobility choices and behaviors is extensive. Therefore, in developing policies and implementing interventions to encourage ecological and sustainable urban mobility, it appears crucial to consider environmental and psychological factors as well as socioeconomic variables that act as mediators.

The primary focus of the present overview was to explore the role of psychological factors underpinning PEB and to highlight the effect of values, beliefs, norms, and habits on the frequency of use of sustainable mobility modes. The scientific contributions presented highlight environmental factors' significance in influencing the adoption and utilization of shared mobility services, emphasizing the need to consider psychological dimensions alongside socioeconomic variables in research on the topic and in intervention aimed at fostering behavioral changes toward sustainability. Considering that these changes imply the ability to cope with technological advancements, the evidence suggests that perceptions and technophilia regarding smartphone applications play a crucial role in encouraging the adoption of shared forms of mobility in urban areas.

The psychological constructs identified have been studied individually in various studies, but the present review is intended to integrate these dimensions into a comprehensive framework. This integrated approach, which combines insights from environmental and psychological research, offers a comprehensive understanding of the factors that drive sustainable mobility behaviors to provide information for developing effective strategies and interventions to promote environmentally friendly transport options in urban environments. By focusing on the psychological dimensions of PEB in the context of sustainable mobility, this report contributes to a deeper understanding of how individual attitudes and behaviors shape the adoption of environment friendly transport alternatives, encouraging the use of shared-transport modes.

Author contributions Idea for the article: M.P.; M.T.; literature search: M.P.; conceptualization: M.P.; M.T.; writing—original draft preparation: M.P.; figures drawing 1, 2: M.P.; writing—review and editing: M.P.; M.T.; funding acquisition: M.T.; supervision and critical revision: M.T. All authors reviewed the manuscript.

Funding This work was supported by the MOST—Sustainable Mobility National Research Center and received funding from the European Union Next-GenerationEU (PIANO NAZIONALE DI RIPRESA E RESILIENZA (PNRR)—MISSIONE 4 COMPONENTE 2, INVESTIMENTO 1.4—D.D. 1033 17/06/2022, CN00000023). This manuscript reflects only the authors' views and opinions, neither the European Union nor the European Commission can be considered responsible for them.

Data availability No datasets were generated or analysed during the current study.

Declarations

Competing interests The authors declare no competing interests.

References

1. Montello DR. Navigation. In: Shah P, Miyake A, editors. The Cambridge handbook of visuospatial thinking. New York: Cambridge University Press; 2005. p. 257–94. https://doi.org/10.1017/CBO9780511610448.008.
2. Barbosa H, Barthelemy M, Ghoshal G, James CR, Lenormand M, Louail T, Menezes R, Ramasco JJ, Simini F, Tomasini M. Human mobility: models and applications. Phys Rep. 2018;734:1–74. https://doi.org/10.1016/j.physrep.2018.01.001.
3. Foltýnová HB, Vejchodská E, Rybová K, Květoň V. Sustainable urban mobility: one definition, different stakeholders' opinions. Transp Res Part Transp Environ. 2020;87:102465. https://doi.org/10.1016/j.trd.2020.102465.
4. Gudmundsson H, Regmi MB. Developing sustainable urban transport index. Transp Commun Bull Asia Pac. 2017;87:35–53.
5. Marsden G, Kimble M, Nellthorp J, Kelly C. Sustainability assessment: the definition deficit. Int J Sustain Transp. 2010;4:189–211. https://doi.org/10.1080/15568310902825699.
6. Boonstra B, Boelens L. Self-organization in urban development: towards a new perspective on spatial planning. Urban Res Pract. 2011;4:99–122. https://doi.org/10.1080/17535069.2011.579767.
7. Machado CAS, De Salles Hue NPM, Berssaneti FT, Quintanilha JA. An overview of Shared mobility. Sustainability. 2018;10:4342. https://doi.org/10.3390/su10124342.
8. Shaheen S, Chan N, Bansal A, Cohen A. Shared mobility: a sustainability & technologies workshop: definitions, industry developments, and early understanding. 2015.
9. Shaheen S, Cohen A. Shared ride services in North America: definitions, impacts, and the future of pooling. Transp Rev. 2019;39:427–42. https://doi.org/10.1080/01441647.2018.1497728.
10. Banister D. The sustainable mobility paradigm. Transp Policy. 2008;15:73–80. https://doi.org/10.1016/j.tranpol.2007.10.005.
11. Pojani D, Stead D. The urban transport crisis in emerging economies: an introduction. In: Pojani D, Stead D, editors. The urban transport crisis in emerging economies. The urban book series. Cham: Springer International Publishing; 2017. p. 1–10. https://doi.org/10.1007/978-3-319-43851-1_1.
12. Chen XM, Zahiri M, Zhang S. Understanding ridesplitting behavior of on-demand ride services: an ensemble learning approach. Transp Res Part C Emerg Technol. 2017;76:51–70. https://doi.org/10.1016/j.trc.2016.12.018.
13. Nikitas A, Kougias I, Alyavina E, Njoya Tchouamou E. How can autonomous and connected vehicles, electromobility, brt, hyperloop, shared use mobility and mobility-as-a-service shape transport futures for the context of smart cities? Urban Sci. 2017;1:36. https://doi.org/10.3390/urbansci1040036.
14. Kollmuss A, Agyeman J. Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behavior? Environ Educ Res. 2002;8:239–60. https://doi.org/10.1080/13504620220145401.
15. Steg L, Vlek C. Encouraging pro-environmental behaviour: an integrative review and research agenda. J Environ Psychol. 2009;29:309–17. https://doi.org/10.1016/j.jenvp.2008.10.004.
16. Stern PC. New environmental theories: toward a coherent theory of environmentally significant behavior. J Soc Issues. 2000;56:407–24. https://doi.org/10.1111/0022-4537.00175.
17. Larson LR, Stedman RC, Cooper CB, Decker DJ. Understanding the multi-dimensional structure of pro-environmental behavior. J Environ Psychol. 2015;43:112–24. https://doi.org/10.1016/j.jenvp.2015.06.004.
18. Jensen BB, Knowledge. Action and pro-environmental behaviour. Environ Educ Res. 2002;8:325–34. https://doi.org/10.1080/13504620220145474.
19. Li D, Zhao L, Ma S, Shao S, Zhang L. What influences an individual's pro-environmental behavior? A literature review. Resour Conserv Recycl. 2019;146:28–34. https://doi.org/10.1016/j.resconrec.2019.03.024.
20. Moisander J. Motivational complexity of green consumerism. Int J Consum Stud. 2007;31:404–9. https://doi.org/10.1111/j.1470-6431.2007.00586.x.
21. Liu P, Teng M, Han C. How does environmental knowledge translate into pro-environmental behaviors? The mediating role of environmental attitudes and behavioral intentions. Sci Total Environ. 2020;728:138126. https://doi.org/10.1016/j.scitotenv.2020.138126.
22. Gatersleben B, Murtagh N, Abrahamse W. Values, identity and pro-environmental behaviour. Contemp Soc Sci. 2014;9:374–92. https://doi.org/10.1080/21582041.2012.682086.
23. Wyss AM, Berger S, Knoch D. Pro-environmental behavior in a common-resource dilemma: the role of beliefs. J Environ Psychol. 2023;92:102160. https://doi.org/10.1016/j.jenvp.2023.102160.

24. Hinds J, Sparks P. Engaging with the natural environment: the role of affective connection and identity. J Environ Psychol. 2008;28:109–20. https://doi.org/10.1016/j.jenvp.2007.11.001.
25. Gökmen A. The effect of gender on environmental attitude: a meta-analysis study. J Pedagog Res. 2021;5:243–57. https://doi.org/10.33902/JPR.2021167799.
26. Zhao M, Dong S, Wu HC, Li Y, Su T, Xia B, Zheng J, Guo X. Key impact factors of visitors' environmentally responsible behaviour: personality traits or interpretive services? A case study of Beijing's Yuyuantan Urban Park, China. Asia Pac. J Tour Res. 2018;23:792–805. https://doi.org/10.1080/10941665.2018.1493518.
27. Costa PT, McCrae RR. Normal personality assessment in clinical practice: the NEO personality inventory. Psychol Assess. 1992;4:5–13. https://doi.org/10.1037/1040-3590.4.1.5.
28. Hunecke M, Haustein S, Böhler S, Grischkat S. Attitude-based target groups to reduce the ecological impact of daily mobility behavior. Environ Behav. 2010;42:3–43. https://doi.org/10.1177/0013916508319587.
29. Nogueira M, Dias F, Santos V. Sustainable mobility choices: exploring the impact of consumers' values, attitudes, perceived behavioural control and subjective norms on the likelihood to choose sustainable mobility options. J Consum Behav. 2023;22:511–28. https://doi.org/10.1002/cb.2144.
30. Gardner GT, Stern PC. The short list: the most effective actions U.S. households can take to curb climate change. Environ Sci Policy Sustain Dev. 2008;50:12–25. https://doi.org/10.3200/ENVT.50.5.12-25.
31. Clayton S, Devine-Wright P, Stern PC, Whitmarsh L, Carrico A, Steg L, Swim J, Bonnes M. Psychological research and global climate change. Nat Clim Change. 2015;5:640–6. https://doi.org/10.1038/nclimate2622.
32. Jin F, Yao E, An K. Understanding customers' battery electric vehicle sharing adoption based on hybrid choice model. J Clean Prod. 2020;258:120764. https://doi.org/10.1016/j.jclepro.2020.120764.
33. Hjorteset MA, Böcker L. Car sharing in Norwegian urban areas: examining interest, intention and the decision to enrol. Transp Res Part Transp Environ. 2020;84:102322. https://doi.org/10.1016/j.trd.2020.102322.
34. Mattia G, Guglielmetti Mugion R, Principato L. Shared mobility as a driver for sustainable consumptions: the intention to re-use free-floating car sharing. J Clean Prod. 2019;237:117404. https://doi.org/10.1016/j.jclepro.2019.06.235.
35. Gomez J, Aguilera-García Á, Dias FF, Bhat CR, Vassallo JM. Adoption and frequency of use of ride-hailing services in a European city: the case of Madrid. Transp Res Part C Emerg Technol. 2021;131:103359. https://doi.org/10.1016/j.trc.2021.103359.
36. Aguilera-García Á, Gomez J, Antoniou C, Vassallo JM. Behavioral factors impacting adoption and frequency of use of carsharing: a tale of two European cities. Transp Policy. 2022;123:55–72. https://doi.org/10.1016/j.tranpol.2022.04.007.
37. Aguilera-García Á, Gomez J, Rangel T, Baeza MDLÁ, Vassallo JM. Which factors influence the use of shared and privately-owned e-scooters in the city of Madrid? Implications for urban mobility. Cities. 2024;147:104785. https://doi.org/10.1016/j.cities.2023.104785.
38. Litman T. Valuing transit service quality improvements. J Public Transp. 2008;11:43–63. https://doi.org/10.5038/2375-0901.11.2.3.
39. Grison E, Gyselinck V, Burkhardt J-M. Exploring factors related to users' experience of public transport route choice: influence of context and users profiles. Cogn Technol Work. 2016;18:287–301. https://doi.org/10.1007/s10111-015-0359-6.
40. Eccarius T, Lu C-C. Adoption intentions for micro-mobility— insights from electric scooter sharing in Taiwan. Transp Res Part Transp Environ. 2020;84:102327. https://doi.org/10.1016/j.trd.2020.102327.
41. Stern PC, Dietz T, Abel T, Guagnano GA, Kalof L. A value-belief-norm theory of support for social movements: the case of environmentalism. Hum Ecol Rev. 1999;6:81–97.
42. Schwartz SH. Are there universal aspects in the structure and contents of human values? J Soc Issues. 1994;50:19–45. https://doi.org/10.1111/j.1540-4560.1994.tb01196.x.
43. Schwartz SH. Universals in the content and structure of values: theoretical advances and empirical tests in 20 countries. In: Zanna MP, editor. Advances in experimental social psychology, vol. 25. Cambridge: Academic Press; 1992. p. 1–25. https://doi.org/10.1016/S0065-2601(08)60281-6.
44. Dunlap RE, Liere KDV. The new environmental paradigm. J Environ Educ. 1978;9:10–9. https://doi.org/10.1080/00958964.1978.10801875.
45. Dunlap RE, Van Liere KD, Mertig AG, Jones RE. New trends in measuring environmental attitudes: measuring endorsement of the new ecological paradigm: a revised NEP scale. J Soc Issues. 2000;56:425–42. https://doi.org/10.1111/0022-4537.00176.
46. Gifford R, Nilsson A. Personal and social factors that influence pro-environmental concern and behaviour: a review. Int J Psychol. 2014;49:141–57. https://doi.org/10.1002/ijop.12034.
47. Webb TL, Sheeran P. Does changing behavioral intentions engender behavior change? A meta-analysis of the experimental evidence. Psychol Bull. 2006;132:249–68. https://doi.org/10.1037/0033-2909.132.2.249.
48. Aarts H, Dijksterhuis A. Habits as knowledge structures: automaticity in goal-directed behavior. J Pers Soc Psychol. 2000;78:53–63. https://doi.org/10.1037/0022-3514.78.1.53.
49. Verplanken B, Aarts H, Van Knippenberg A. Habit, information acquisition, and the process of making travel mode choices. Eur J Soc Psychol. 1997;27:539–60.
50. Mitra R, Hess PM. Who are the potential users of shared e-scooters? An examination of socio-demographic, attitudinal and environmental factors. Travel Behav Soc. 2021;23:100–7. https://doi.org/10.1016/j.tbs.2020.12.004.
51. Blazanin G, Mondal A, Asmussen KE, Bhat CR. E-scooter sharing and bikesharing systems: an individual-level analysis of factors affecting first-use and use frequency. Transp Res Part C Emerg Technol. 2022;135:103515. https://doi.org/10.1016/j.trc.2021.103515.
52. Vega-Gonzalo M, Aguilera-García Á, Gomez J, Vassallo JM. Analysing individuals' use of moped-sharing and their perception about future private car dependency. Cities. 2024;146:104741. https://doi.org/10.1016/j.cities.2023.104741.
53. Zaigham M, Chin CP-Y, Dasan J. Disentangling determinants of ride-hailing services among Malaysian drivers. Information. 2022;13:584. https://doi.org/10.3390/info13120584.
54. Schlüter J, Weyer J. Car sharing as a means to raise acceptance of electric vehicles: an empirical study on regime change in automobility. Transp Res Part F Traffic Psychol Behav. 2019;60:185–201. https://doi.org/10.1016/j.trf.2018.09.005.
55. Ruhrort L, Steiner J, Graff A, Hinkeldein D, Hoffmann C. Carsharing with electric vehicles in the context of users' mobility needs—results from user-centred research from the BeMobility field trial (Berlin). Int J Automot Technol Manag. 2014;14:286–305. https://doi.org/10.1504/IJATM.2014.065294.

56. Wappelhorst S, Sauer M, Hinkeldein D, Bocherding A, Glaß T. Potential of electric carsharing in urban and rural areas. Transp Res Procedia. 2014;4:374–86. https://doi.org/10.1016/j.trpro.2014.11.028.